Doctor of Business Economics

The impact of off-site construction transport on air quality

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Abstract

While transport is inevitable in our economy and daily lives, it also engenders negative effects on the society and environment. The effects of air pollution are responsible for more than 364,200 premature deaths in Europe each year. Most urban areas still exceed the NO_x and PM WHO air quality guidelines, of which a large share of pollutants is attributable to freight transport. The construction sector forms no exception, as it intrinsically strongly relies on off-site logistics activities, i.e. transports to and from sites. Although construction works lead to an urban economic uptake on the long-haul, the environmental nuisances from construction logistic (CL) activities during the works have so far been overlooked. This thesis focuses on the air quality impact of off-site construction transport, covering four main parts. First, as there is a lack of knowledge within cities on how to set construction transport demands and how to involve actors in these processes, a stakeholder framework is presented. Next, I identify the available and required transport data (and digitization possibilities) to assess the sector's environmental impact, such as On-Board Units. Secondly, impact assessments were conducted across various construction supply chain implementations, on single-site, city-wide and national level. Hence, a methodological approach to derive construction-related vehicles from Heavy-Goods Vehicle (HGV) traffic based on algorithmic and geospatial analyses is proposed. Results indicate that construction transport represents 26.40% of total HGV traffic in the Brussels-Capital Region (BCR), generating €45,631.85 of external costs per workday, and 17.58% in Belgium (or €1.45mio per day). Subsequently, the framework was deployed to assess the transport performance of the multimodal Brussels Construction Consolidation Centre. The use of this setup can mitigate external costs by up to 59% compared to business-as-usual operations, most notably on congestion and climate change costs. However, improvements are necessary to tackle local emissions, attributable to less performant -yet ubiquitous- vessel engines. Air pollution damage costs also remain high on city level analyses, with CL inflicting €55,123.07 per month (or €2,505.59 per workday) in the BCR. A fortiori, with the growing concern on urban air quality, this raises the question of where, when and by whom the most exposure costs are inflicted. So far, the geo-temporal link between the emitting freight vehicle and its receptor densities was considered static. The third part introduces a dynamic impact-pathway approach, highlighting that PM & NO_2 source impacts engender €61.604 of health costs in the BCR each day. Large differences were found on the local level compared to the traditional static approach, indicating that the proposed dynamic methodology should be used for micro-scale analyses (on link, building or neighborhood level). Striking is that vulnerable population segments such as toddlers, school children and elderly, who are more sensible to the effects of air pollution, incur 60.28% of the total health costs, although these segments represent only a quarter of the BCR population. Moreover, a strong overlap

was found between the receptor's presence (in particular children) and peak freight traffic movements. The fourth part investigates the exposure effects when off-site construction transport flows are spatiotemporally rerouted around air pollution hotspots. Although an increase in emissions is observed due to higher travelled distances and slower driving speeds, results show that the inflicted health costs can be mitigated up to 25.53%. Conclusively, this study suggests to decouple policies from absolute transport emissions and focus on the actual health impact, considering the spatiotemporal relationship of both emissions and receptors. Although tailoring a one-size-fits-all construction logistic plan can initially prove to be difficult due to the unique character of each construction site's supply chain, the conducted studies also show that this individual complexity can be overcome by overall better integrated urban transport planning, and can ultimately lead to significant sustainability benefits.